CLAIMS

What is claimed is:

1. A gate structure for a transistor in a semiconductor device, the gate structure comprising:

a dielectric structure formed over a semiconductor body, the dielectric structure comprising:

a bulk portion comprising a high-k dielectric material, the high-k dielectric material of the bulk portion comprising a nitrogen concentration of about 3 atomic percent or more and a nitrogen concentration variation of about 4 percent or less; and

an interface portion comprising a dielectric material between the bulk portion and the semiconductor body, the interface portion having a nitrogen concentration of about 3 atomic percent or less; and

a gate electrode structure comprising a conductive material formed over the bulk portion of the dielectric structure.

2. The gate structure of claim 1, wherein the high-k dielectric material of the bulk portion comprises a nitrogen concentration of about 40 atomic percent or less.

3. The gate structure of claim 2, wherein the high-k dielectric material of the bulk portion comprises a nitrogen concentration variation of about 3 percent or less.

4. The gate structure of claim 3, wherein the high-k dielectric material of the bulk portion is a metal silicon oxynitride, and wherein the metal is selected from the group consisting of Zr, Hf, La, Y, Gd, Eu, Pr, and Ce.

5. The gate structure of claim 4, wherein the high-k dielectric material of the bulk portion is HfSiON.

6. The gate structure of claim 1, wherein the high-k dielectric material of the bulk portion is a metal silicon oxynitride, and wherein the metal is selected from the group consisting of Zr, Hf, La, Y, Gd, Eu, Pr, and Ce.

7. The gate structure of claim 6, wherein the high-k dielectric material of the bulk portion is HfSiON.

8. The gate structure of claim 1, wherein the high-k dielectric material of the bulk portion comprises a nitrogen concentration variation of about 3 percent or less.

9. The gate structure of claim 1, wherein the interface portion of the dielectric structure is about 3 monolayers thick or less.

10. A gate dielectric structure in a semiconductor device, the gate dielectric structure comprising:

a bulk portion comprising a high-k dielectric material, the high-k dielectric material of the bulk portion comprising a nitrogen concentration of about 3 atomic percent or more and a nitrogen concentration variation of about 4 atomic percent or less; and

an interface portion comprising a dielectric material between the bulk portion and a semiconductor body, the interface portion having a nitrogen concentration of about 3 atomic percent or less.

11. The gate structure of claim 10, wherein the interface portion of the dielectric structure is about 3 monolayers thick or less.

12. The gate dielectric structure of claim 10, wherein the high-k dielectric material of the bulk portion comprises a nitrogen concentration of about 40 atomic percent or less.

13. The gate dielectric structure of claim 10, wherein the high-k dielectric material of the bulk portion comprises a nitrogen concentration variation of about 3 percent or less.

14. The gate dielectric structure of claim 10, wherein the high-k dielectric material of the bulk portion is a metal silicon oxynitride, and wherein the metal is selected from the group consisting of Zr, Hf, La, Y, Gd, Eu, Pr, and Ce.

15. The gate dielectric structure of claim 14, wherein the high-k dielectric material of the bulk portion is HfSiON.

16. A method of forming a transistor gate structure, the method comprising:

depositing a high-k dielectric material over a semiconductor body using a deposition process;

introducing nitrogen into the high-k dielectric material using a plasma nitridation process;

annealing the nitrided high-k dielectric material;

forming a gate electrode layer over a bulk portion of the high-k dielectric material; and

patterning the gate electrode layer and the high-k dielectric material to provide a transistor gate structure.

17. The method of claim 16, wherein the deposition process is selected from the group consisting of CVD, ALD, and PVD.

18. The method of claim 16, wherein the high-k dielectric material comprises a nitrogen concentration of about 40 atomic percent or less.

19. The method of claim 16, wherein the bulk portion of the high-k dielectric material has a nitrogen concentration variation of about 4 atomic percent or less.

20. The method of claim 16, wherein the high-k dielectric material is a metal silicon oxynitride, and wherein the metal is selected from the group consisting of Zr, Hf, La, Y, Gd, Eu, Pr, and Ce.

21. The method of claim 16, wherein the high-k dielectric material is HfSiON.